



IN SATURATION MODE.

$$R_c = \frac{V_{cc} - V_{CE(sat)}}{I_{c(sat)}}$$

$$R_B = ?$$

ACTIVE MODE

$$I_c = \beta I_B$$

$$I_{c(sat)} = \beta I_{B'}$$

$I_B > I_{B'} \rightarrow$  then we have saturation mode.

$$I_B > \frac{I_{c(sat)}}{\beta} \quad \left. \vphantom{I_B} \right\} \text{in saturation.} \quad (1)$$

IN SATURATION

$$I_B R_i + I_B R_B + V_{BE} = V_{in}$$

$$I_B = \frac{V_{in} - V_{BE}}{R_i + R_B} \quad (2)$$

$$(2) \rightarrow (1) \quad \frac{V_{in} - V_{BE}}{R_i + R_B} > \frac{I_{c(sat)}}{\beta}$$

$$\beta(V_{in} - V_{BE}) > (R_i + R_B) I_{c(sat)}$$

$$R_B < \frac{(V_{in} - V_{BE}) \beta}{I_{c(sat)}} - R_i$$

for fastest circuit

## IN CUT OFF MODE

$$V_{out} \geq V_{out}'$$

Voltage required to  
power next stage.

$$I_l = \frac{V_{cc}}{R_c + R_l}$$

$$V_{out} = R_l \cdot I_c$$

$$V_{out} = \frac{R_l}{R_c + R_l} V_{cc} \geq V_{out}'$$

$$R_c V_{cc} \geq V_{out}' (R_c + R_l)$$

$$R_c (V_{cc} - V_{out}') \geq V_{out}' R_l$$

$$R_l \geq \frac{V_{out}' R_c}{V_{cc} - V_{out}'}$$

